one of phosphoric acid (bi-calcic), and one part of lime, two of water and one of phosphoric acid (mono-calcic). In the first state phosphate of lime is altogether useless, as the phosphoric acid is inert or insoluble; in the second state it is more or less soluble in water, and only in the last (combination) is it really directly available to the plant. Phosphoric acid, in this available state, is firmly held by the soil and does not evaporate or wash out like nitrogen, but it may change its relation with lime under certain conditions with the soil, and revert back to an insoluble state. Hence the need of its being continually supplied to the growing crops in a soluble form, and the necessity of its continued application to partially worn out land, in order that it may be diffused through the interstices of the soil which supply the roots with nourishment, and in order that it may be there in a soluble or active state. There is an abundance of this phosphate of lime in the mineral state, or apatite, both in Ontario and Quebec, but it is nearly all exported to England and the U. S. These mines should supply an almost inexhaustible supply of manure to our farmers. And, besides this, there is a constant supply of this element in bones, but, like the apatite, they are carted away to the U. S., and manufactured for the use of the crops of the American farmers. Mr. D. Lamb, of Toronto, said before the Ontario Agricultural Commission, that Canada was the only country in the world that exports bones, and further, that of all the material handled by him that could be turned into superphosphates, he exported 95 per cent., and only manufactured 5 per cent. for use in Canada. One hundred tons was for use here, and 2,000 tons of bone was annually exported. Why such a lack of interest is taken in the use of this manure I am at a loss to know, and certainly it does not reflect much credit on the advanced ideas of Canadian farmers. Experience has shown that the application of 350 lbs. of mineral superphosphate to the acre, has increased a crop of turnips nearly one hundred per cent. over the same land unmanured. A good profit could be had at $30 a ton, and our manufacturers charge $40. However, whilst mineral superphospates are amongst the most valuable of manures, yet they are not always attended with equally good results, as it is only when the soils are deficient in phosphates that they are beneficial, and the permanent effect, too, of these will depend greatly on the nature of the soil upon which they are applied.

On strong, calcareous soil, the lime is apt to absorb the sulphuric acid contained in the manufactured phosphates, and cause it to revert back, or to be changed to its original state of an insoluble phosphate or tri-calcic lime.

POTASH

is the next element, and, generally speaking, it is found in sufficient quantities for plant-food in the ordinary run of soils. Yet it is of the greatest importance that there should always be on hand a good supply, as there is no danger of waste, as it is held by the soil with great tenacity. These three elements of plant-food, besides their nutritive properties, appear to have a physiological effect on the structure of the plant, distinct from that of their action as nutritive materials. I noticed, last summer especially, an excessive leaf-growth in plants where there was an over-supply of nitrogenous material; phosphoric acid, again, in excess causes the production of fruit and the extension of fibrous roots; potash a determination of nutrient changes originating in the leaf. In short, any of these elements in excess, or where there is an undue proportion of the one over the other, the plant has not a normal growth. Artificial manure, then, that will supply these important elements in due proportion, would appear to be the one that should be of the greatest value to the farmer. But then there is no such thing as a universal manure which is equally good for all crops, any more than there is a cure-all medicine. And this results from two causes. First, that different plants require different food, and different soils are not similarly effected by the supply of these elements of plant-food. This is an important consideration—What relation does the soil bear to the manure? Or, does the soil always bear the same relation? Is the physical and chemical condition of your soil always the same? And is there an unvarying relation between the fertilizers applied and your land? No; the soil has never a settled equilibrium; it is never in the same condition at any two periods. There is the action of water on soluble material, such as the washing out of nitrates, referred to before, and carrying them to the sub-soil, or into drains. (Lawe calculates there are from 12 to 14 lbs. per acre carried away in a year in drainage). Then there is the oxygen of the air, which is constantly in action, to disintegrate and form other chemical combinations. Each change of temperature, evaporation, rainfall, etc., so affects the condition of the soil that no definite rule can be laid down for the preparation and application of artificial manures, and the effect of such on growing crops. (I have seen fields of wheat, last harvest, where everything necessary—as far as plant-food is concerned—was in the soil, but, unfortunately, through the modifications and changes undergone by the soil since last fall, the crop was a complete failure). Hence the position of a farmer with regard to plant fertilization, or the application of artificial manures, is a most difficult one; for he has—in the first place—to apply elements to his soil which are subject to change as soon as they come in contact with the soil, and to a soil which itself is undergoing a continual series of changes; and it is only by experiments that our farmers can arrive at anything like a definite knowledge of the effects of artificial manures on certain crops. And this brings us to consider that certain crops require different proportions of the plant elements—nitrogen, phosphoric acid, potash—that we have mentioned; for instance, it is found that in varying proportions certain plants require more of one of these elements than another, and that some plants are more exhaustive upon soils than others; some plants abstract a large amount of potash; another exhausts the phosphoric acid, and a third is dominant in the amount of lime it uses up; and to make an intelligent application of artificial manures, and get the full benefit of the same, a certain knowledge of these classes of plants is necessary, and the kind of plant-food most required. There are but few farmers but know that they must manure their land, or feed the plant, but the question is, how? It is certainly not in the haphazard way, so commonly followed by our farmers, of putting on a certain amount of superphosphates, lime, salt, or anything else, without considering the effect that it is desirable to produce, or without reference to the value of the crop. I am fully persuaded that between those who apply manures injudiciously, and those who do not manure at all—a large proportion of all the farmers—that the former is the greater loser in his crops. The practice that is to bring success to our farmers in the application of manures, is that which brings certainty with use, and which reduces waste in the application of their manure, and which allows of the largest net profits.

All manures or plant-food have, or should have, a commercial value, and must cost so much, and, as I have said, the plant feeds upon the soluble part of the soil of which but three elements require to be supp ied.

To give the chemical preparation and proportion of these to different crops would only be repeating the vague and unsatisfactory experiments of a number of agricultural chemists, and would be of little importance in an essay like this, as all the formulæ for preparing manures for different crops can be easily bought, and this by the eminent French chemist and agriculturist, M. Ville. It could hardly be supposed that a farmer in Ontario could even approach the subject of the preparation of manures, with the limited means he has at his command, and to do justice to the subject. Barnyard manure is about the only thing he wants to thoroughly understand at best, and from a proper knowledge of this he will be enabled to know just what is lacking in this plant element. If a Canadian farmer has found out, after a proper rotation of crops and system of farming, and economizing the dung pile, that there is yet something wanting to make his crops grow, then he is in a fit state of mind to follow a higher class of farming and experiment for himself in artificial manures, and in the application of the three important elements of plant-food, potash, nitrogen and phosphoric acid.

The dung pile, then, is the starting point, and let us see what elements it contains and what it supplies to the soil. A ton of well rotted barnyard manure only contains a little over 11 lbs. of nitrogen, 10 lbs. of potash, and 6 lbs. of phosphoric acid. Now, for most crops this is only an imperfect manure; take wheat for instance, and with this ratio the composition of the manure and the wheat (grain) and straw does not correspond. For, in 30 bushels of wheat, say the product of an acre, there are over 76 lbs. of nitrogen, 19 of potash, and 15 of phosphoric acid taken off in the crop, and to supply this waste it would take nearly 7 tons of manure for the nitrogen, but there would be an excess of and a needless expenditure of the other two elements in the number of tons; but by a slight calculation we find two tons of barnyard manure will supply the dose of potash; but in that we shall only have 21 lbs. of nitrogen instead of 76, and 11 lbs. phosphoric acid instead of 15 lbs. Now, if we apply sulphate of ammonia, say 157 lbs., or less of nitrate of soda, we should make up the supply of nitrogen required per acre; and if we further add 31 lbs. of superphosphate of lime of a good per cent. of purity, say 26 per cent. of bone—earth soluble—we shall make up 15 lbs. of phosphoric acid. Thus 2 tons of manure, chemically, would do the duty most efficiently of 7 tons, supposing they could be evenly distributed over so large a space as an acre. This illustration is only suggestive and leads to the consideration of artificial manures in a strictly scientific sense—given the composition of a plant, and the elements that produce that plant, to raise it at the least cost. I need hardly say that tables of analyses have been compiled by men like Voelcker, Wolf, and Ville, which proximately show the amount of food required by each plant and also the per centage of plant food contained in several kinds of manure. These tables are a species of agricultural arithmetic similar to interest tables, but not applicable under all conditions and in all cases. It would hence be foreign to an essay of this kind, to give formulæ for the preparation of manures, when such are already furnished by such eminent experimenters as Ville, March and Wolf. The individual experience of any person who competes for this prize could hardly, without a great amount of egotism, be brought forward to establish one fact. The subject is of such wide scope, and embraces so many considerations, that the best a writer can do is to offer suggestions, and place before his readers a few well-established principles. The best of our scientific agriculturists, however, who have spent a life in careful study and investigation, offer only a few generalizations. On the farm-yard manure questions, take the experiments of Dr. Lawes for 32 years on manured and unmanured land, and without giving the different experiments for this length of time, they may be epitomized thus: That he raised the productive power of a field by applying 14 tons of barn-yard manure every year, from 12½ bushels to the acre to 35½ bushels. Or, in this time there was an average of 18¼ bushels to the acre. But to accomplish this it took a ton of manure to produce a bushel of wheat; or, in other words, producing wheat at a greater cost than it was worth. And this should be the great consideration of a farmer, *profitable fertility*, or producing the greatest results from the least expenditure of capital and labor. Now, this experiment of Lawes shows plainly, that but about one-fifth of the nitrogen applied was recovered in the crop increase, about one-seventh of the phosphoric acid, and but one-thirteenth of the potash. Again, it shows that it is only through the continual application of barnyard and artificial manures that the highest maximum effects were reached and the best results obtained.

[To be continued in next issue.]

By the Way.

In Ohio the farmers have abandoned the old plan of working out the road tax. The roads are kept in repair by contract, and the result is much better roadways, really costing no more money than under the old system.

If there are thin places in the meadow or pasture a little grass seed sown now and harrowed in will greatly improve the future yield. Covering with a light dressing of manure and harrowing once or twice will also help improve the yield.

Cane sugar and syrup are no longer exclusively tropical products. The increase in the sorghum industry promises to make it a leading crop with northern farmers. It is a fact not generally known that the amber sorghum cane is best in northern latitudes. It ripens in ninety to 100 days, and during this time the farther north it is grown the more sunlight it gets per day.

A correspondent of the *Rural New Yorker* says he tried the plan advocated by a contributor to that journal, of cuttng his seed potatoes five weeks before planting, dusting them with plaster, spreading them four inches deep and shoveling them over once a week. When he planted them the sprouts were fully started. They came up, he tells us, in ten or twelve days, and he thinks he gained a week in earliness.